PATENT SPECIFICATION

DRAWINGS ATTACHED

1,004,370

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Int. Cl.:—F 06 j

COMPLETE SPECIFICATION

Improvements relating to means for Effecting a Seal between Two Coaxial Cylindrical Surfaces

We, GESELLSCHAFT FÜR LINDE'S EISMASCHINEN AKTIENGESELLSCHAFT, of Wiesbaden, Germany, a German Company, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to means for effecting a seal between two coaxial cylindrical surfaces, for example the peripheral surface of a piston and the bore of the cylinder in which the piston works, or the corresponding surfaces of a stuffing box and the piston rod or other part in sealed relation thereto, the invention having reference to such sealing means of the kind comprising at least one sealing ring associated with a carrier element therefor which is held in fixed relation to the part (stuffing box, piston or the like) carrying the ring and carrier element when these members are in assembled position relative to one another and which in the event of there being two or more sealing rings and associated carrier elements serves to maintain the rings in mutually spaced relation to one another axially of the assembly.

It is known to seal pistons in cylinders by inserting sealing rings which are split at one point around the ring, in grooves provided for their reception in the periphery of the piston, the rings being pressed resiliently against the cylinder wall. In such sealing rings, the parting at the split in the ring must be such that the two ends of the ring which are disposed opposite one another can be pushed together in the plane of the ring. The surfaces of the two ends of the ring must therefore not touch at the parting; an open gap must be left between the ends, the width of which in the plane of the ring is not greater than the extent to which the circumference of the ring can be reduced by resilent compression. This type of ring is referred to as an open joint ring. At the open joint of the ring, i.e. at the parting at the split in the ring, there is formed an open duct through which can take place leakage of gases past the ring, the cross-section of which duct can be calculated from the width of the gap between the ring ends multiplied by the piston clearance between the periphery of the piston and the cylinder wall. The sealing effect is reduced by the presence of this duct.

In a modified constructional form of sealing ring of this general type the parting has a stepped form, part of the step shape extending in the plane of the ring and the two adjacent parts of the step shape extending at right angles to the plane of the ring. If the sections of the parting which extend at right angles to the plane of the ring each have an open gap, the sealing ring can be compressed by the width of these open gaps. In this construction, in spite of the open gaps, there are no open ducts for leakage gases, because the gaps are covered in each case by a part of the sealing ring, or in some cases by a tensioning spring located radially behind the rings. This construction, having a step-overlap joint, has the drawback that in the region of the parting the sealing ring is mechanically very weak, in particular as regards the forces acting normally to the plane of the ring; also the ring ends tend to break off easily at the parting, particularly in the case of non-lubricated sealing rings.

If the known forms of sealing means of the kind to which the invention relates, for reasons of safety, the outer surfaces of the carrier elements must be at a certain distance, in the operative state of the sealing means, from the surface of the cylinder wall, piston rod or other part to be sealed. This distance is about 1/50 to 1/100 of the corresponding diameter of the carrier element, according to the nature of the mounting of the moving parts. The sealing rings held by the carrier elements rest on the surface to be sealed and hence project from the carrier element into

the gap which is formed by the clearance between said corresponding diameter of the carrier element and the surface to be sealed. In non-lubricated sealing means in particular, the friction between the sealing rings and the wall to be sealed may become so great that the material of the sealing ring is forced into the gap between the carrier element and the wall to be sealed, i.e. the sealing rings extrude into this gap. Such extrusion occurs to a particular degree especially when plastic are employed, the sealing effect of the sealing means being then reduced considerably and the life of the sealing rings (their so-called durability) being very short.

The problem on which the present invention is based is to overcome the drawbacks mentioned and produce a form of sealing means of the kind described, using a one-piece split sealing ring or rings, which will combine a high sealing action with long life of the sealing ring or rings and which, moreover, will be of simple design and cheap to manufacture.

The invention consists in sealing means, more particularly a non-lubricated sealing means, of the kind described, for effecting a seal between two coaxial cylindrical surfaces, wherein the sealing ring, or each sealing ring, is a one-piece split ring associated with a supporting ring interposed axially of the ring between the sealing ring and the associated carrier element, the sealing ring being arranged in front of the supporting ring in the direction of the pressure drop to be produced and supporting ring projecting beyond the periphery of the carrier element into the gap between the latter and the surface to be sealed to a position in which it is just clear of said surface.

The invention is capable of a variety of advantageous developments. Thus, it is advantageous if the supporting ring be radially movable in the carrier element. It is also advantageous if at working temperature the diameter of the supporting ring, referred to the circumference disposed opposite the surface to be sealed, differs by about 1/500 to 1/1000, preferably 1/500, from the diameter associated with the surface to be sealed.

The sealing means of this invention can be employed for alternate sealing in two opposite directions, the direction of the pressure drop to be produced turning through 180° in each case in each two successive periods, which case occurs regularly in double-acting pistons. In this instance the sealing means according to the invention should comprise, in association with each sealing ring, two supporting rings, the arrangement being one in which, in respect of each sealing ring, there is a suporting ring, a sealing ring and a supporting ring arranged in succession axially of the rings.

The sealing means of this invention is rendered particularly cheap to manufacture and is afforded a long useful life if the sealing ring or rings is or are split radially and at right angles to the plane of the ring, the surfaces of the parting of the ring at the two ends thereof which are then formed being out of contact with one another in the working position of the ring.

It is advantageous, particularly in the case of a non-lubricated sealing means in accordance with this invention, that the sealing ring, or each sealing ring, and the associated supporting ring or rings are composed of a material having good dry-running properties. The supporting ring or rings should at the same time consist of a material having good heat - conducting properties, preferably a bronze having a high lead content. The heat produced in the sealing ring by the friction can in such case be carried off easily by the supporting ring or rings.

The sealing ring is given good dry-running properties if it is made of electrographited high-grade carbon or thermoplastic with a friction reducing filler, such as molybdenum disulphide. The presence of a filler also improves the strength properties and the thermal conductivity of the sealing ring. Two or more different fillers may be employed at the same time.

Sealing rings made of plastics and carbon do not in general have the inherent elasticity necessary for them to press elastically at their sealing surfaces against the surface to be sealed. For this reason, in the sealing means according to this invention, spring elements which press the sealing ring against the surface to be sealed may be used with the ring.

A particularly advantageous application of the sealing means of this invention in a stuffing box is one in which a plurality of sealing rings, each associated with a supporting ring and a carrier element, are arranged one behind the other and a suction chamber sealed off from the outside atmosphere by at least two sealing rings of known type is arranged in the direction of the pressure drop to be produced, behind the two or more sets of sealing elements, supporting rings and carrier elements. With such an arrangement harmful leakage gases can be drawn off through the suction chamber before they issue to the outside atmosphere. The stuffing box then has all the advantages of the sealing means of this invention, in spite of the fact that the suction chamber is sealed off from the outside atmosphere merely by means of sealing rings of known type, because the suction chamber does not exhibit any great pressure difference on the outside and hence the sealing rings of known type are subjected only to slight pressure.

Finally, the carrier elements may have cavities in them through which cooling water can circulate, with the result that frictional heat

is carried off from the sealing rings by the cooling water.

Further advantages and details of the invention will appear from the following description of the accompanying drawings.

In these drawings:—

Figure 1 shews a known arrangement for sealing a piston in a cylinder, piston rings of the type shewn in Figure 2 and Figure 3 being employed, and sealing rings according to Figure 2 being also employed in the improved sealing means of the present invention;

Figure 4 illustrates a form of sealing means according to the present invention for sealing a piston in a cylinder, the piston being loaded essentially by the excess gas pressure from a single direction, namely from above in the Figure;

Figure 5 shews on a larger scale a single sealing ring and its associated supporting ring and carrier element, a plurality of such sets of parts being used in the arrangement illustrated in Figure 4;

Figure 6 illustrates a form of sealing means according to the present invention for sealing a piston in a cylinder, the piston being loaded alternately from two opposite directions by an excess gas pressure;

Figure 7 shews on a larger scale a single sealing ring and its associated supporting rings and carrier element as used in the arrangement illustrated in Figure 6; and

Figure 8 shews a sealing means according to the present invention for sealing a piston rod with respect to a cylindrical housing (not shewn) of any kind, the loading of the sealing means by pressure taking place from only one direction.

Like reference numerals are used to denote like parts in all the Figures.

In Figure 1, 1 denotes the cylinder wall and 2 the piston. Fast with piston 2 is a piston rod 3. In grooves 4 in the piston 2 are inserted piston rings 5 which, if inherent elasticity is lacking, can be forced outwardly by means of tensioning spring 6.

Between piston 2 and cylinder wall 1 is an annular gap 7, the width of which varies with the extent to which the piston can oscillate on the piston rod 3 in a direction at right angles to the axis of the rod.

Figure 2 shews a plain open-joint sealing ring having a single split the parting of which is in a single plane radial to the ring and at right angles to the plane of the ring the surfaces of the two ends of the ring are not in contact at the parting, so that an open gap 8 is formed. In the arrangement according to Figure 1, the open gap of the sealing ring (which as already remarked is of the type illustrated in Figure 2) is partially sealed by the side walls of the groove 4. In the region of the annular gap 7, however, the open gap 8 forms a duct through which leakage gases can flow unimpeded.

Figure 3 shews a piston ring having a single split. The parting of this ring is, however, in stepped form, part of the step shape extending in the plane of the ring and the two adjacent parts of the step shape extending in planes radial to the ring and angularly spaced from one another around the axis of the ring. In this way, the parting forms two overlapping ring ends 9 and 10 with two open gaps 11 and 12 extending at right angles to the plane of the ring. The piston ring illustrated in Figure 3 therefore has a step-overlap joint. This step-overlap joint is also tight with respect to leakage gases in the arrangement according to Figure 1. The ends 9 and 10 of the ring are, however, mechanically very weak and tend to break off easily under the action of the friction at the cylinder wall.

In Figure 4 sealing rings of the type illustrated in Figure 2 are more particularly employed. The cylinder wall is marked 13, the piston 14 and the piston rod 15. Onto the piston 14 are pushed carrier elements 16, which are held in position relative to the piston head body on the one hand by a spacer 17 and on the other hand by a closure plate 18.

In each carrier element 16 are inserted a supporting ring 19, a one-piece split sealing ring 20 and a tensioning spring 21 exerting a radially outward pressing action.

In such a construction as is illustrated in Figure 4, a substantially uniform reduction of pressure gradient and hence a substantially uniform pressure load on, and wear of, the individual sealing rings is obtained.

In Figure 5, in which the parts which also appear in Figure 4 are denoted by the same reference numerals as are used in that Figure, the supporting ring 19, which is composed, for example, of bronze having a high lead content, is mounted so as to be radially movable in the carrier element 16. Carrier element 16 forms with cylinder wall 13 an annular gap 22 the width of which varies with the extent to which the piston 14 oscillates in the cylinder in a direction at right angles to the axis of the piston rod 15. The outer diameter of the supporting ring is less than the diameter of the bore of the cylinder by about 1/500 part of that diameter. The piston will frequently oscillate by more than 1/500 of the diameter of the cylinder bore. The supporting ring 19 covers, however, a large part of the gap 22 and practically does not move at right angles to the cylinder wall.

The sealing ring 20 is supported by the supporting ring 19 in the region of the gap 22 against the pressure operating upon it in the gap. The sealing ring 20 has a straight open-joint, in accordance with the construction illustrated in Figure 2, and is composed, for instance, of polytetrafluoroethylene. The open gap at the parting of the sealing ring 20 is almost completely covered by the supporting

ring 19, so that only a small amount of leakage gas can flow through.

The heat produced by the friction is conducted away satisfactorily from the sealing ring 20 by way of the supporting ring 19 to the carrier element 16.

As the material of the sealing ring 20 does not have any substantial inherent elasticity, a tensioning spring 21 having a radially outward pressing action on the ring is placed behind the sealing ring 20 and constantly presses the latter tightly against the cylinder wall 13.

The construction illustrated in Figure 7 corresponds substantially to that illustrated in Figure 5, like parts in the two Figures being designated accordingly by the same reference numerals.

The piston 14 of the arrangement illustrated in Figure 6 is double-acting and is loaded by pressure operating upon it on each side alternately. For this reason, in each carrier element 16, in addition to a sealing ring 20, two supporting rings 19 are so arranged, one on either side of the sealing ring, that the sealing ring is backed by a supporting ring in both directions of movement. Consequently, in this arrangement the material of the sealing ring 20, which material is fundamentally soft, is prevented from being extruded in to the gap 22 between the carrier element 16 and the cylinder wall 13, because the supporting ring 19, which is composed of very much more resistant material almost completely covers the gap 22 and prevents any such extrusion.

In each of the embodiments of the invention illustrated in Figures 1 to 7, the member carrying the sealing means is a movable part, while the surface to be sealed is stationary. Figure 8 shews by way of example the opposite case, where a stationary housing (not shown) carries sealing means according to the present invention which seal the gap between the housing and a piston rod 23.

The sealing means of this Figure form in effect a stuffing box packing comprising two carrier elements 24 each containing a single-split sealing ring 25 and a supporting ring 26. The sealing rings 25 have only a slight inherent elasticity and are pressed against the piston rod 23 by ring-shaped springs 28.

Between the piston rod 23 and each of the carrier elements 24 is an annular gap 27 which is almost completely covered by the supporting ring 26. The sealing rings 25, therefore, also rest closely on the supporting rings 26 in the region of the annular gap 27, the supporting rings 26 almost completely covering the open gaps at the partings of the sealing rings, on the one hand, and preventing any extrusion of the material of the sealing rings into the annular gap 27, on the other hand.

The heat produced as a result of the friction between the piston rod 23 and the sealing rings 25 is transmitted to the carrier elements 24 by way of the supporting rings 26.

The carrier elements 24 are formed interiorly with cooling chambers 30 which communicate with one another by way of mutually staggered connecting ducts 31 and a cooling medium, for example water, flows through the cooling chambers 30 and connecting ducts 31. In this way very effective cooling of the sealing rings is obtained.

The stuffing box packing illustrated in Figure 8 also comprises an additional carrier element 33 and a closure plate 34 which together with two sealing rings 36 of known type enclose a suction chamber 32. Leakage gases flowing through the stuffing box packing accumulate in the suction chamber 32 and are carried off through a suction duct 37 in the carrier element 33. The suction duct 37 may, for example, communicate with the suction side of a compressor or a vacuum pump.

The suction chamber 32 is shut off from the external atmosphere by the sealing rings 36, which may be either of the type illustrated in Figure 2 or of the type shewn in Figure 3. No great pressure difference obtains between the suction chamber 32 and the external atmosphere. The sealing rings 36 are therefore loaded only to a small extent. Consequently it is not necessary to place any supporting rings behind the sealing rings 36. These rings may, however, be pressed against the piston rod 23 by ring-shaped springs 29.

It will be seen therefore that the stuffing box packing of Figure 8 embodies all of the advantages of the present invention in spite of the fact that the sealing rings which are located within the carrier element 33 are constructed in accordance with known types.

The sealing means of this invention can be employed with advantage in combination with known forms of sealing means. It is possible, for instance, by means of such a combination to distribute the progressive reduction of pressure in a stuffing box, or at the periphery of a piston, more satisfactorily, thereby equalising the loading of the individual sealing rings.

WHAT WE CLAIM IS:—

1. Sealing means, more particularly a non-lubricated sealing means, of the kind described, for effecting a seal between two coaxial cylindrical surfaces, wherein the sealing ring, or each sealing ring, is a one-piece split ring associated with a supporting ring interposed axially of the ring between the sealing ring and the associated carrier element, the sealing ring being arranged in front of the supporting ring in the direction of the pressure drop to be produced and the supporting ring projecting beyond the periphery of the carrier element into the gap between the latter and the surface to be sealed to a position in which it is just clear of said surface.

2. Sealing means according to Claim 1, wherein the supporting ring is radially movable in the carrier element.

3. Sealing means according to Claim 1 or 2, wherein at working temperature the diameter of the supporting ring, referred to the circumference disposed opposite the surface to be sealed, differs by about 1/500 to 1/1000 from the diameter associated with the surface to be sealed.

4. Sealing means according to any of Claims 1 to 3 for sealing alternately in two opposite directions, wherein the sealing ring, or each sealing ring, is associated with two supporting rings, one on each side of it axially of the rings, giving an arrangement in which there are a supporting ring, a sealing ring and a supporting ring arranged in succession.

5. Sealing means according to any of Claims 1 to 4, wherein the sealing ring is split radially and at right angles to the plane of the ring, the surfaces of the parting which is then formed not being in contact in the working position of the ring.

6. Sealing means according to any of Claims 1 to 5, wherein the sealing ring or rings and the supporting ring or rings are composed of a material having good dry-running properties.

7. Sealing means according to any of Claims 1 to 6, wherein the supporting ring or rings is or are composed of a material having good heat-conducting properties, preferably a bronze having a high lead content.

8. Sealing means according to any of Claims 1 to 7, wherein the sealing ring or rings is or are composed of electro-graphited high-grade carbon or thermoplastic with a friction reducing filler such as molybdenum disulphide.

9. Sealing means according to any of Claims 1 to 8, wherein a spring element which presses the sealing ring against the surface to be sealed is associated with the sealing ring, or each sealing ring.

10. A stuffing box packing incorporating a sealing means according to any of Claims 1 to 9, comprising a first plurality of sealing rings each associated with a supporting ring and a carrier element, said sealing rings being arranged coaxially, in combination with a second plurality of sealing rings arranged coaxially with said first plurality and located on that side of said first plurality towards which the pressure drop is to be produced, said second plurality sealing off a suction chamber located between the two pluralities which is placeable in communication with suction means by way of a duct means incorporated in the structure.

11. A stuffing box packing according to Claim 10, wherein said duct means consists of a duct leading from said suction chamber through an additional carrier element associated with the second plurality of sealing rings and located between said second plurality and said first plurality.

12. Sealing means for effecting a seal between two coaxial cylindrical surfaces, constructed, arranged and adapted to operate substantially as hereinbefore described with reference to Figures 2 to 8 of the accompanying drawings.

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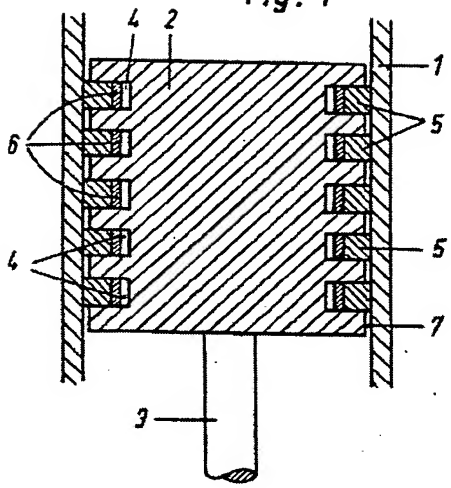
Fig. 1



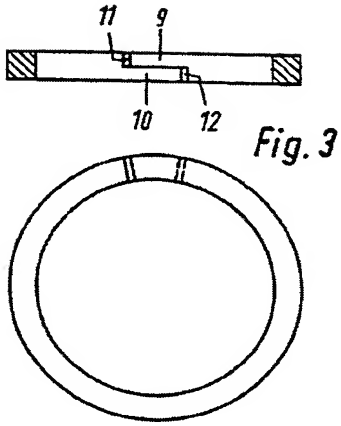


Fig. 3

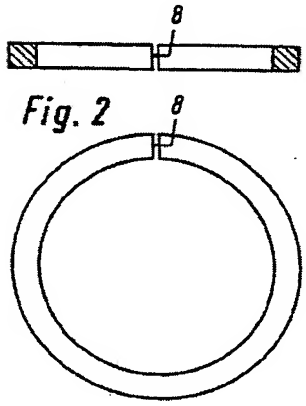


Fig. 2

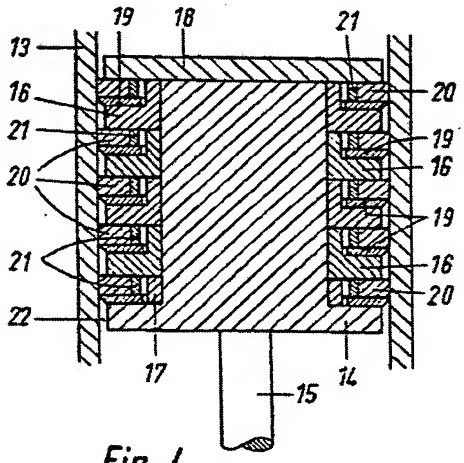


Fig. 4

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Fig. 3

Fig. 5

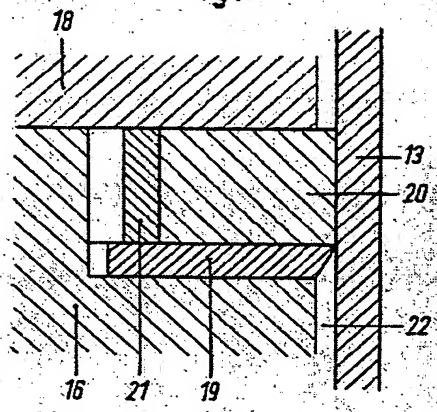
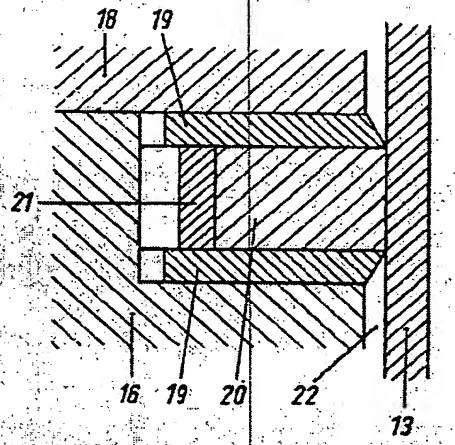
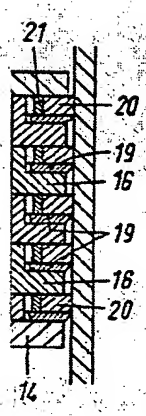


Fig. 7





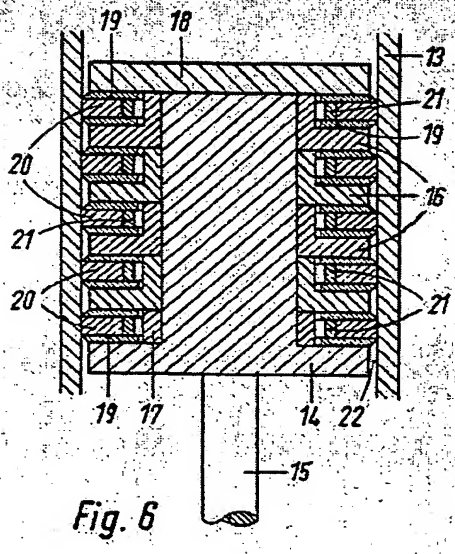


Fig. 6

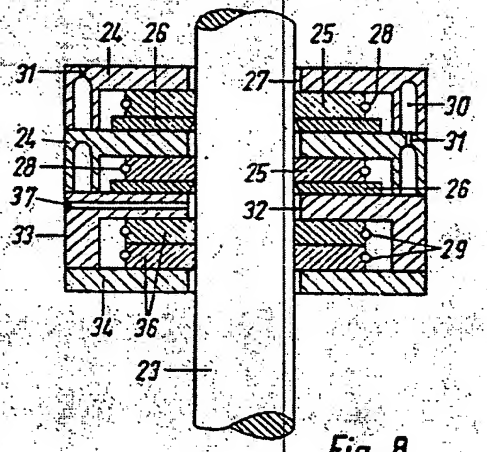


Fig. 8

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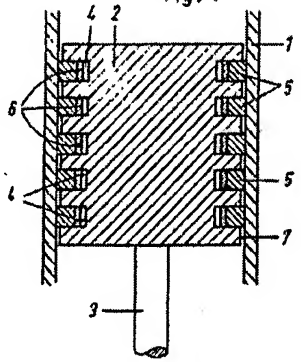
SHEETS 1 & 2

Fig. 1



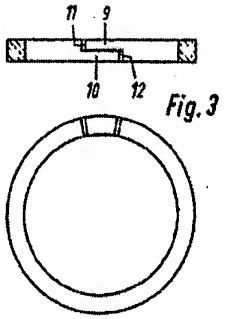


Fig. 3

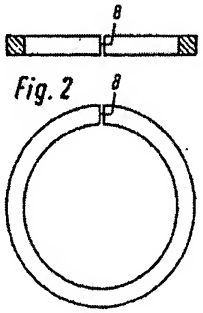


Fig. 2

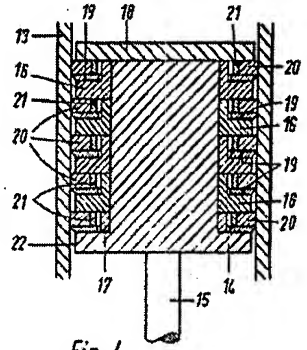


Fig. 4

Fig. 5

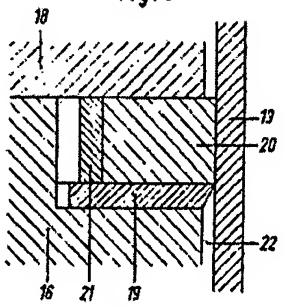
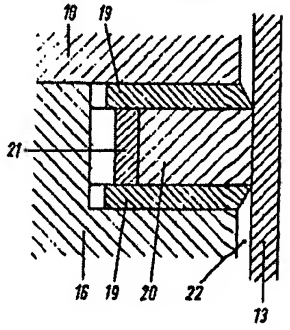


Fig. 7



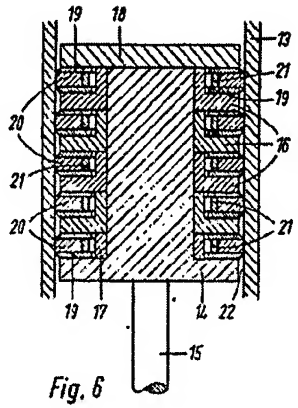


Fig. 6

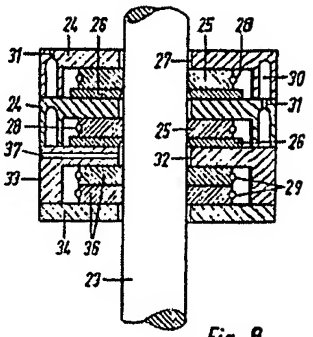


Fig. 8